

WHAT IS CLAIMED IS:

1. A method for fabricating a nanowire thermoelectric device comprising the steps of:

providing a substrate upon which to form nanowires, wherein the substrate comprises substrate electrodes passing from a top exposed surface of the substrate to a bottom exposed surface of the substrate;

forming a first electrode pattern on the bottom surface of the substrate, wherein the first electrode pattern forms a plurality of electrically connected groups of substrate electrodes;

forming a p-type nanowire on the substrate by activating at least one electrically connected group of substrate electrodes;

forming a n-type nanowire on the substrate by activating at least one other electrically connected group of substrate electrodes;

forming top electrodes to connect the p-type nanowire and the n-type nanowire and

forming a second electrode pattern on the bottom surface of the substrate to replace the first electrode pattern such that a thermocouple is formed.

2. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein the substrate is provided by a method comprising the steps of:

depositing an electrode layer on a temporary substrate material;

selectively removing areas of the electrode layer to leave electrode pads;

depositing substrate materials around and on top of the electrode pads;
and
removing the temporary substrate and the substrate material above the electrodes.

3. The method for fabricating a nanowire thermoelectric device according to Claim 1, further comprising the steps of disposing a nanopore formation layer on the substrate and forming nanopores in the nanopore formation layer after the nanopore formation layer is disposed on the substrate.

4. The method for fabricating a nanowire thermoelectric device according to Claim 3, wherein the nanopores in the nanopore formation layer are registered to the substrate electrodes.

5. The method for fabricating a nanowire thermoelectric device according to Claim 3, wherein the nanopore formation layer comprises Al and anodic oxidation is used to create nanopores within the nanopore formation layer.

6. The method for fabricating a nanowire thermoelectric device according to Claim 5, wherein the nanopore formation layer is removed prior to completion of the thermoelectric device.

7. The method for fabricating a nanowire thermoelectric device according to Claim 6, where in the nanopore formation layer is not removed until after

the second electrode pattern is formed.

8. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein either the p-type nanowire or the n-type nanowire is formed prior to the formation of another type of nanowire.

9. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein many thermocouples are formed and are connected in series and/or parallel by the second electrode pattern.

10. The method for fabricating a nanowire thermoelectric device according to Claim 9, wherein the thermocouples form banks of series connected thermocouples and the banks of series connected thermocouples are connected in parallel.

11. The method for fabricating a nanowire thermoelectric device according to Claim 9, further comprising the step of applying a general purpose optimization algorithm to determine a second electrode pattern which optimizes the connection of the many thermocouples.

12. The method for fabricating a nanowire thermoelectric device according to Claim 9, further comprising the step of applying a genetic algorithm to determine a second electrode pattern which optimizes the connection of the many thermocouples.

13. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein more than one p-type nanowire is formed; more than one n-type nanowire is formed; and more than one top electrode is formed, wherein the top electrodes are formed to connect one of the p-type nanowires to one of the n-type nanowires.

14. The method for fabricating a nanowire thermoelectric device according to Claim 1, further comprising the steps of:
forming a second conducting layer on the bottom surface of the substrate over the first electrode pattern; and
forming the second electrode pattern using the second conducting layer.

15. The method for fabricating a nanowire thermoelectric device according to Claim 1, further comprising the steps of encapsulating the substrate and nanowire thermocouples to form a nanowire thermoelectric module and creating a vacuum around the nanowires.

16. The method for fabricating a nanowire thermoelectric device according to Claim 1, further comprising the steps of encapsulating the substrate and nanowire thermocouples to form a nanowire thermoelectric module; and attaching a pyrolitic sheet to the thermoelectric module.

17. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein the p-type nanowires and n-type nanowires are formed by electrochemical deposition.

18. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein the p-type nanowires and n-type nanowires formed have a diameter of 5nm to 500nm.

19. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein the p-type nanowires and n-type nanowires formed have a diameter of 5nm to 100nm.

20. The method for fabricating a nanowire thermoelectric device according to Claim 1, wherein the p-type nanowires and n-type nanowires formed have a diameter of 10nm to 50nm.

21. A method for fabricating a nanowire thermoelectric device comprising the steps of:

providing a substrate upon which to form nanowires, wherein the substrate comprises substrate electrodes passing from a top surface of the substrate to a bottom surface of the substrate, and wherein the substrate electrodes are electrically connected to each other by a first conducting layer disposed on the bottom surface of the substrate;

forming a first electrode pattern using the first conducting layer, wherein

the first electrode pattern forms first and second electrically connected groups of substrate electrodes;

disposing a nanopore formation layer on the substrate within which nanopores may be formed;

forming nanopores within the nanopore formation layer after disposing the nanopore formation layer on the substrate, such that the nanopores are registered to the substrate electrodes;

forming a p-type nanowire in some of the nanopores by activating the first electrically connected group of substrate electrodes during a p-type material deposition;

forming a n-type nanowire in some of the nanopores by activating the second electrically connected group of substrate electrodes during n-type material deposition;

forming top electrodes on the nanopore formation layer to connect the p-type nanowire to the n-type nanowire;

replacing the first electrode pattern with a second electrode pattern on the bottom surface of the substrate to form nanowire thermocouples,

wherein the nanowire thermocouples form either a serial or a parallel connection or a combination of both; and

encapsulating the substrate and nanowire thermocouples to form a nanowire thermoelectric module.